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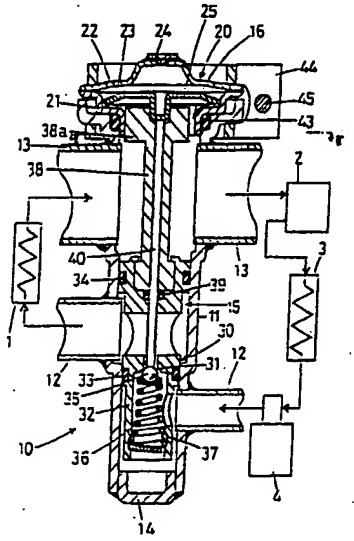
(54) Unit type expansion valve

(57) In a unit-type expansion valve (10) a barrel-shaped valve casing (11) is provided to penetrate a high-pressure refrigerant passage (12) and a low-pressure refrigerant passage (13) sideways. The inside diameter of the low-pressure refrigerant passage (13) is not smaller than inside diameter of the high-pressure refrigerant passage (12). A unit (15) is inserted into the valve casing (12) from the side of the lower-pressure refrigerant passage (13). Said unit (15) is integrally composed of a thermo-sensitive chamber (20) and a valve mechanism (30). The thermal-sensitive chamber (20) is disposed in the opening at the inlet of the valve casing (11) so that this opening is closed by the thermo-sensitive member (20). The unit (15) as a whole can be pulled out from the valve casing by pulling the thermo-sensitive chamber (20) outwardly.

FIG 1



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Description

The invention relates to a unit type-expansion valve, particularly for an automotive air conditioning system, generally for a cooling circuit, according to the preamble part of claim 1.

In an expansion valve as known (JP-Publication 4-113664 EP0438625-B1) the thermo-sensitive chamber senses any change in temperature of refrigerant in the low-pressure refrigerant passage on the side of an evaporator outlet to hereby raise or lower the pressure therein accordingly. The valve mechanism is driven by the raised or lowered pressuring the thermo-sensitive chamber to hereby open or close the high-pressure refrigerant passage on the side of the evaporator inlet. The thermo-sensitive chamber and the valve mechanism form integrally prefabricated unit so that no re-adjustment is required once the interlocking relationship between the thermo-sensitive chamber and the valve mechanism is adjusted as well as facilitating the assembly, thereby reducing the assembly costs greatly. In the expansion valve as known from JP-Publication 4-11366, however, after inserting the prefabricated unit into the valve casing, a closure lid had to be fitted into the opening at inlet of the valve casing to thereby airtightly close the opening. The part cost of an airtightly closing lid accounts for the greater part of the entire costs, e.g. almost half of the entire costs. In the expansion valve, as known from EPO 438625B1 the thermo-sensitive chamber is encapsulated within a solid valve casing having thick casing walls and stepped connecting bores for the tubing. The opening for inserting the unit into the valve casing is closed by a costly airtightly closing lid.

An expansion valve as known from FR-A-2535485 comprises a solid, thick walled valve casing. Into an insertion opening of the valve casing the thermo-sensitive chamber is screwed in an airtight manner. The design of the valve casing is bulky. Manufacturing the chamber component with a thread and providing a counter-thread in the casing is costly and require cost consuming assembly steps.

In an expansion valve as known from US-4-4819443 the prefabricated unit is inserted into a solid and thick-walled valve casing from the high-pressure side so that the thermo-sensitive chamber is completely encapsulated within the valve casing. The insertion opening in the high-pressure region of the valve casing is airtightly closed by an inserted plug.

In an expansion valve as known from EP 0513568 A1 the prefabricated unit is received in a solid, thick-walled valve casing. The unit is inserted into the valve casing from the low-pressure side. The thermo-sensitive chamber at least partially is exposed to the surroundings and is screwed with a sealing member into the insertion opening. Stepped connecting holes are provided in the thick wall of the valve casing for the tubing constituting the high-pressure and low-pressure passages.

It is an object of the invention to provide a unit type-expansion valve with high economical efficiency capable of reducing effectively and greatly both the assembly costs and the part costs. Moreover, it is of utmost importance to achieve an expansion valve with a compact, easy to manufacture and space-saving valve casing.

Said object is achieved in the unit type-expansion valve having the features as contained in claim 1.

Consequently, the unit in which the thermo-sensitive chamber and the valve mechanism are integrally formed linearly is inserted into the valve casing so that the entire unit can be drawn or pulled out of the valve casing by pulling the thermo-sensitive chamber portion outwardly. Therefore, it is very easy to assemble and disassemble the expansion valve, and it is not necessary to re-adjust the valve mechanism even during reassembling. The thermo-sensitive chamber is disposed in the opening at the inlet of the valve casing to close the opening. Hence, no special part for covering or closing the opening is required, thus greatly reducing the part costs.

The embodiment according to claim 2 is easy to manufacture, easy to assemble and to disassemble. The mounting seat with its cylindrical collar only has to be shifted linearly into the opening of the valve casing until it reaches an airtight sliding fit. The whole unit then is centered in the cavity of the valve casing. No costly to manufacture thread connection is necessary. The additionally provided fixing arrangement secures the unit in the valve casing and maintains the airtight closing of the valve casing opening at the low-pressure side.

In the embodiment according to claim 3 the airtight closing of the opening of the valve casing is easily achieved. The O-ring co-operates with the collar. The cylindrical centering portion co-operating with the collar centers the chamber and the unit in the correct position: The assembly or disassembly needs only a linear pushing or pulling motion of the unit.

Claim 4 contains an embodiment of particular importance. The barrel-shaped valve casing is easy to manufacture with precise dimensions and leads to a compact and space-saving design of the expansion valve, which is particularly important for automotive applications where space for the air conditioning system normally is extremely restricted. The essentially constant wall thickness moreover is advantageous in view to welding the tubing for the fluid passages into the valve casing.

The embodiment according to claim 5 is easy to manufacture. The valve casing is rigid and lightweight. It can be manufactured with precise dimensions in a mass production with the help of simple tooling and machinery. The material of the valve casing can easily be recycled.

The embodiment according to claim 6 perfectly meets with the requirement of low cost manufacturing, facilitated assembly and disassembly, and easy installing of the expansion valve into an air conditioning system. The stepped configuration of the valve casing leads to a slim and space saving design of the expansion valve.

In the embodiment according to claim 7, the unit is easy to prefabricate and allows easy assembly or disassembly of the expansion valve because all active or pas-

sive components of the unit are connected with each other.

The embodiment of claim 8 is of particular importance, because it relates to a very simple reliable mounting of the valve spring, the pre load of which, can be varied upon demand. The number of necessary parts for the valve mechanism is kept at a minimum which further reduces part costs and weight.

The embodiment of according to claim 9 is easy to manufacture and assures a reliable connection between both parts of the unit.

The embodiment according to claim 10 is important because it relates to a simple way to connect the thermo-sensitive chamber with the rest of the components of the unit with a minimum number of parts. The mounting seat fulfils a dual-function, because it serves to airtightly close the opening of the valve casing and simultaneously connects the thermo-sensitive chamber with the other components of the unit.

Claim 11 relates to a low cost but reliable fixing arrangement assuring the air tight closing of the valve casing. The fixing arrangement is easy to handle, is reliable and light-weight.

The embodiment according to claim 12 further contributes to low manufacturing costs, because such welding connections can be made quickly and reliably without costly, time consuming preparation of the interconnected components.

The embodiment of claim 13 is of particular importance. When welding the evaporator, any special process for connecting the typing becomes unnecessary, since the piping constituting the refrigerant passages is welded to the valve casing and the evaporator at the same time thus greatly reducing the assembly costs.

In the embodiment according to claim 14, said welding connections are made in a high temperature chamber and simultaneously, even by also welding the connections between the valve casing and the tubing connecting the expansion valve with a compressor and/or the refrigerant reservoir. The sub assembly of the evaporator and the valve casing with the tubing can easily be prefabricated. This saves manufacturing costs. No costly pipe connecting elements or fittings are necessary. The valve casing can be positioned extremely close to the evaporator.

An embodiment of the invention will be described with the help of the drawings. In the drawings is :

Figure 1 a refrigerating circuit component sectional view,

Figure 2 a perspective exploded view of the components which is shown in Figure 1., and

Figure 3 a fragmentary plan section view of the upper part of the component which is shown in Figure 1 in longitudinal section.

Figure 1 shows a refrigerating cycle comprising an evaporator 1; a compressor 2; a condenser 3; a liquid receiver 4 containing high-pressure refrigerant; and an expansion valve 10.

A high-pressure refrigerant passage 12 connected to the outlet of the liquid receiver 4 is connected to the inlet of the evaporator 1. A low-pressure refrigerant passage 13 connected to the outlet of the evaporator 1 is connected to the inlet of the compressor 2.

A barrel-shaped valve casing 11 is connected to the high-pressure refrigerant passage 12 and the low-pressure refrigerant passage 13 so as to penetrate them sideways. These connections are adhered, for example, by aluminium welding.

The high-pressure refrigerant passage 12 is connected to the valve casing 11 with the inlet side in deviated or offset relationship with the outlet side. A bottom lid 14 or plug is adhered to the bottom of the valve casing 11 also by aluminium welding.

When aluminium welding the laminated evaporator 1 (Figure 2) in a high-temperature chamber, the high-pressure refrigerant passage 12, the low-pressure refrigerant passage 13, the bottom lid 14 and the like are also aluminium welded to the valve 11 in the high-temperature chamber at the same time.

Accordingly, any special assembly process for connecting and adhering the high pressure refrigerant passage and the assembly cost for that portion can be greatly reduced.

As shown in Figs. 1 and 2, the end portion of the valve casing 11 on the side of the low-pressure refrigerant passage 13 is open. The other end portion is closed by lid 14. The diameters of the intermediate portions is changed for each piping connection gradually so that the inside diameter on the opening side is large, and the inside diameter on the bottom side is small. The valve casing 11 thus includes cylindrical wall sections of different diameters, but an essentially constant wall thickness. The big diameter opening of the valve casing 11 is surrounded by an annular flange.

In the valve casing 11, a unit 15 in which a thermo-sensitive chamber 20, a valve mechanism 30 and the like are integrally provided, is inserted from the opening side and displaced or linearly shifted into the position of Figure 1. In operation, the thermo-sensitive chamber 20 senses any change in temperature of refrigerant in the low-pressure refrigerant passage 13 to thereby raise or lower the pressure therein. The valve mechanism 30 is driven by the raised/lowered pressure in the thermo-sensitive chamber 20 to open or close the high-pressure refrigerant passage 12.

Of the parts constituting the unit 15, a body barrel 32 with a valve seat 31 formed is fitted to the inside of the portion or cylindrical wall section of the valve casing 11, to which the high-pressure refrigerant passage 12 is connected, and the fitted surface is installed with O-rings 33 and 34 for sealing.

A spherical valve body 35 disposed facing to a valve seat 31 is biased toward the valve seat 31 by means of a valve spring 36 (compression coil spring with frustoconical shape). Since the basic end or the last spring

turns 37 of the compression coil spring 36 is threaded onto a helical groove (thread profile) formed on the inner surface of the body barrel 32, the compression coil spring 36 can be rotated about its axis to thereby adjust its biasing force against valve body 35.

A supporting barrel 38 as part of unit 15 disposed to traverse the low-pressure refrigerant passage 13 is fixed to the body barrel 32 by staking the upper end portion to the interior side. A rod 40 is disposed at the central axis position so as to advance or retreat freely through the supporting barrel 38 and the body barrel 32. The part at which the supporting barrel 38 and the body barrel 32 are joined with each other contains an O-ring 39 for sealing the outer peripheral surface of the rod 40. Said part is fitted with O-ring 34 into a second smaller diameter wall section of the valve casing 11.

The upper end of rod 40 extends towards the thermo-sensitive chamber 20. The lower end thereof passes through valve seat 31 and abuts on the valve body 35. When the rod 40 moves the valve body 35 against the biasing force exerted by the compression coil spring 36, the channel sectional area in the high-pressure refrigerant passage 12 changes to vary the amount of the refrigerant to be fed into the evaporator 1 while effecting adiabatic expansion.

A large diameter head 38a of the supporting barrel 38 is formed with a regular hexagonal section. A thermo-sensitive chamber mounting seat 21 is airtightly welded thereto. As shown in Figure. 3, the section of a lower cylindrical collar of the thermo-sensitive chamber mounting seat 21 is circular, and therefore, there is partially clearance 16 (several gaps) between the head 38a of the supporting barrel 38 and the thermo-sensitive chamber mounting seat 21. The refrigerant in the low-pressure refrigerant passage 13 passes through the clearance 16, reaching the rear side of the thermo-sensitive chamber 20.

The thermo-sensitive chamber 20 is airtightly closed by a housing 22 made of a thick metallic plate, and contains a diaphragm 23 in the surface direction is transmitted to the valve body 35 via rod 40.

In operation, the refrigerant in the low-pressure refrigerant passage 13 passes through the clearance 16 to the rear side of the thermo-sensitive chamber 20. The rear side of the diaphragm 23 receives the refrigerant pressure in the low-pressure refrigerant passage 13, so that the temperature of the low-pressure refrigerant is transmitted from the diaphragm 23 to the thermo-sensitive chamber 20 through the backup board 25.

The pressure of refrigerant in the thermo-sensitive chamber 20 changes to raise or lower the pressure in the thermo-sensitive chamber 20. In a condition, where the pressure, the biasing force of the compression coil spring 36 and the pressure of the refrigerant in the low-pressure refrigerant passage 13 are balanced, the diaphragm 23, the valve body 35 and the like stand still to control the amount of the refrigerant to be fed from the high-pressure refrigerant passage 12 to the evaporator 1.

Of the unit 15 which is inserted into the valve casing 11 through the opening on the side of the low-pressure refrigerant passage 13, the thermo-sensitive chamber 20 is located in the opening at the inlet of the valve casing 11 with the opening closed airtightly. Reference numeral 43 designates an O-ring for sealing in this region. O-ring 43 is seated on a radial shoulder in the opening and contacts the collar of mounting seat 21. The collar extends beyond the shoulder and can be centered there.

To prevent unit 15 from slipping out of the valve casing 11, the thermo-sensitive chamber 20 is interposed together with the head of the valve casing 11 by means of an externally provided fixing arrangement, e.g. a two-part bracket 44. Reference numeral 45 designates a fixing screw for fixing the bracket 44. The two parts of the bracket are releasably connected opposite to screw 45. The bracket parts have slots for positively engaging at the rim of chamber 20 and a flange surrounding the opening of the valve casing 11.

Consequently, the unit 15, in which the thermo-sensitive chamber 20 and the valve mechanism 30 are integrally assembled in advance, is inserted into the valve casing 11 as it is, and is fixed with the bracket 44. If the bracket 44 is removed and the thermo-sensitive chamber 20 portion is pulled outwardly, and then the unit 15 as a whole can be drawn out of the valve casing 11.

Even if the unit 15 is thus attached to and detached from the valve casing 11, the biasing force of the compression coil spring 36 and the like do not fluctuate, and therefore, the unit 15 can be re-assembled to the valve casing 11 as it is without necessitating any adjustment or the like.

The unit 15 may be fixed with any member other than the bracket 44.

The barrel-shaped valve casing 11 preferably is a shaped piece of sheet metal. Any type of metal can be used. Preferable is to use aluminium or an aluminium alloy. The valve casing can be secured to the laminated-type evaporator 1 (Figure 2) within a high-temperature chamber at the same time when the evaporator in welded and by aluminium-welding the tubes for the passages 12, 13 by aluminium-welding into the evaporator 1 and into wall holes of the valve casing. At the same time also the further tubes of the passages 12, 13 for connecting the compressor 2 and the reservoir 4 can be aluminium welded to the valve casing 11.

Claims

1. Unit type expansion valve, comprising:
   a valve casing (11) disposed to penetrate a high-pressure refrigerant passage (12) connected to the inlet of an evaporator and a low-pressure refrigerant passage (13) connected to the outlet of the evaporator (1) sideways, which is formed so that the inside diameter of the low-pressure refrigerant passage (13) is not smaller than the inside diameter of the high-pressure refrigerant passage (12); and
   an unit (15) which is integrally composed of a

thermo-sensitive chamber (20) for sensing any change in temperature of refrigerant in the low-pressure refrigerant passage (13) to hereby raise or lower the pressure therein, and a valve mechanism (30) for being driven by the raised/lowered pressure in the thermo-sensitive chamber (20) to hereby open or close the high-pressure refrigerant channel (12), in which said unit (15) is inserted into the valve casing (11) from the side of said low-pressure refrigerant channel (13),
characterised in that
the thermo-sensitive chamber (20) is disposed in the opening at the inlet of the valve casing (11) so that the opening is closed by the thermo-sensitive chamber (20), and that the unit (15) as a whole can be drawn out from the valve casing (11) by pulling the thermo-sensitive chamber portion outwardly.

2. Expansion valve as in claim 1,
characterised in that
the thermo-sensitive chamber (20) is provided with a lower circular mounting seat (21) having a downwardly extending cylindrical collar,
that the mounting seat (21) is positioned with its collar in the opening of the valve casing (11) in an air-tight closing position,
that the closing position is maintained by an externally provided fixing arrangement, and
that the air-tight closing position of the mounting seat (21) is achievable or releasable by a linear pushing or pulling movement of the unit (15) (sliding fit of the collar within the opening) in the direction of its longitudinal axis.

3. Expansion valve as in claim 2,
characterised in that
the opening of the valve casing is provided with an axially extending widened portion and a radially extending shoulder for supporting an O-ring (43), and
that the collar of the mounting seat (91) contacts the O-ring and extends-in insertion direction of the unit (15) beyond the radial shoulder into a cylindrical centering portion formed within the inserting opening of the valve casing (11).

4. Expansion valve as in at least one of claims 1 to 3, characterised by
a barrel-shaped valve casing (11) for receiving the unit (15), said valve casing (11) having an essentially constant wall thickness, preferably slightly thicker than the wall thickness of the tubing constituting the fluid passages (12, 13) between the evaporator (1) and expansion valve (10).

5. Expansion valve as in at least one of claims 1 to 4,
characterised in that
the valve casing (11) is a unitary shaped piece of sheet metal, preferably of aluminium or an aluminium alloy, preferably with circular cross-section.

6. Expansion valve as in at least one of claims 1 to 5,
characterised in that
the barrel-shaped valve casing (11) is open at both ends and is provided with a big diameter chamber-receiving opening at one end and a small diameter plug-receiving opening at the opposite end and comprises interconnected cylindrical wall sections, the diameters of which gradually decrease in direction from the big diameter opening toward the small diameter opening; and comprises preferably, a first cylindrical wall section forming the chamber receiving a centering portion and containing (2) sidewardly opening wall holes for inserting the ends of tubes constituting the low pressure passage (13),
a second cylindrical wall section with smaller diameter than the first wall section, containing one third sidewardly opening wall hole for inserting the end of a tube being part of the high-pressure passage (12), and
a third wall section with smaller diameter than the second wall section, forming a valve mechanism-and-plug-receiving portion and containing a sidewardly opening fourth wall hole for inserting the end of another tube being part of the high-pressure passage (12), said third and fourth wall holes being offset in axial direction of the casing.

7. Expansion valve as in at least one of claims 1 to 6,
characterised in that
the unit (15) comprises
a lower valve mechanism barrel (32) containing an upper receiving head, a lateral passage below said receiving head, a valve-seat (31) and a valve-spring receiving lower barrel portion,
and an upper supporting barrel (38) with a lower end portion received in said upper receiving head and an upper head (38a) carrying the mounting seat (21) and the temperature sensitive chamber (20).

8. An expansion valve as in claim 7,
characterised in that
in the inner wall of the lower barrel portion of the lower valve mechanism barrel (32) a thread profile is provided,
that a valve-coil-compression spring (36) of frusto-conical shape is locked in said thread profile with at least one spring turn (37), the valve spring (36) being threadably secured with its locked spring turn (37) in the thread profile in order to vary the position or the compression preload of the valve spring (36).

9. Expansion valve as in claim 7,
characterised in that
the lower end portion of the upper supporting barrel (38) engages in to the receiving head of the lower

valve mechanism barrel (32) and is secured therein by staking.

10. Expansion valve as in claim 1 and 7, **characterised in that** the upper head (38a) is formed with a polygonal, preferably a regular hexagonal, outer circumference and is located within the cylindrical collar of the mounting seat (21), and that the collar is secured to the upper head (38a) in circumferentially spaced connecting spots, preferably by aluminium welding, such that fluid passing clearances (16) are defined between the collar and the outer polygonal circumference of the upper head (38a).

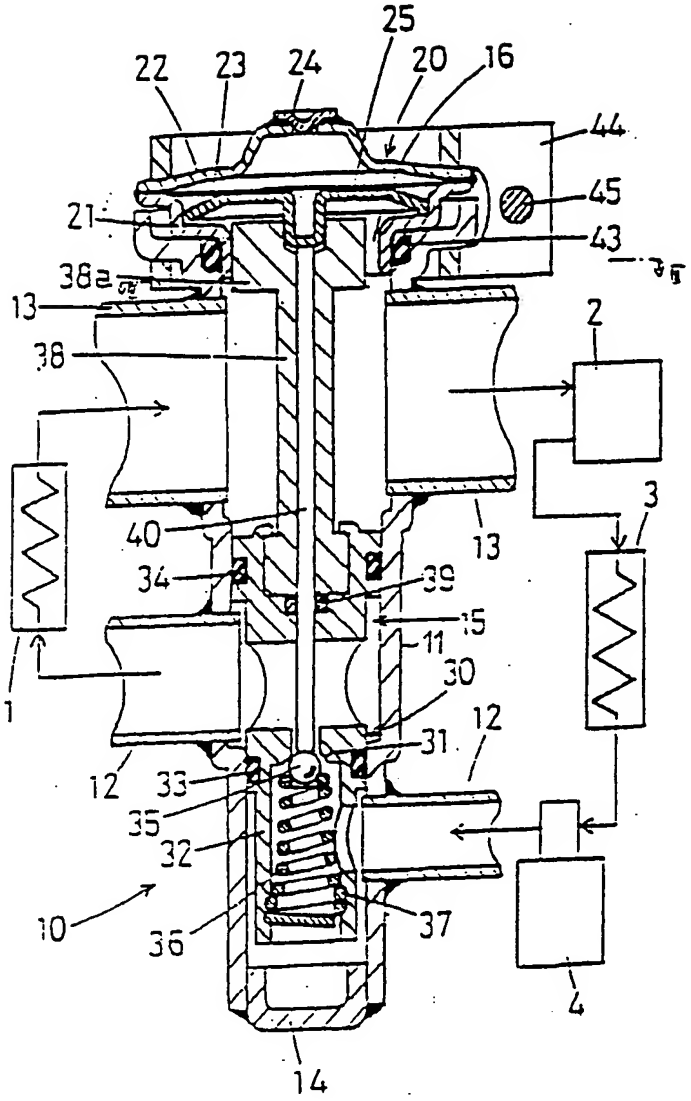
11. Expansion valve as in at least one of claims 1 to 10, **characterised in that** the fixing arrangement consists of a two-part bracket (44) having two positively connectable C-shaped bracket halves and a releasable connecting member (45), each bracket half being provided with a clamping slot for simultaneously engaging at the upper side of the temperature sensitive chamber (20) and the lower side of a casing flange surrounding the big diameter insertion opening of the valve casing (11) upon tightening the connecting member (45).

12. Expansion valve as in at least claims 1 to 11, **characterised in that** the ends of the tubes defining parts of the passages (12, 13), and preferably the plug (14) closing the receiving portion of the valve casing (11), are aluminium-welded to the valve casing wall.

13. Expansion valve according to claim 1, **characterised in that** the piping constituting the refrigerant passages (12, 13) is welded to the valve casing (11) and the evaporator (1) at the same time when the evaporator (1) is welded.

14. Expansion valve according to claim 13, **characterised in that** the valve casing (11) is connected to the evaporator (1) by aluminium welding the evaporator outlet-and inlet tubes to the valve casing (11) simultaneously when welding the laminated-type evaporator (1) in a high-temperature chamber, and that at a the same time the fluid receiver outlet tube (12) and compressor inlet tube (13) are aluminium welded to the wall of the casing (11).

FIG 1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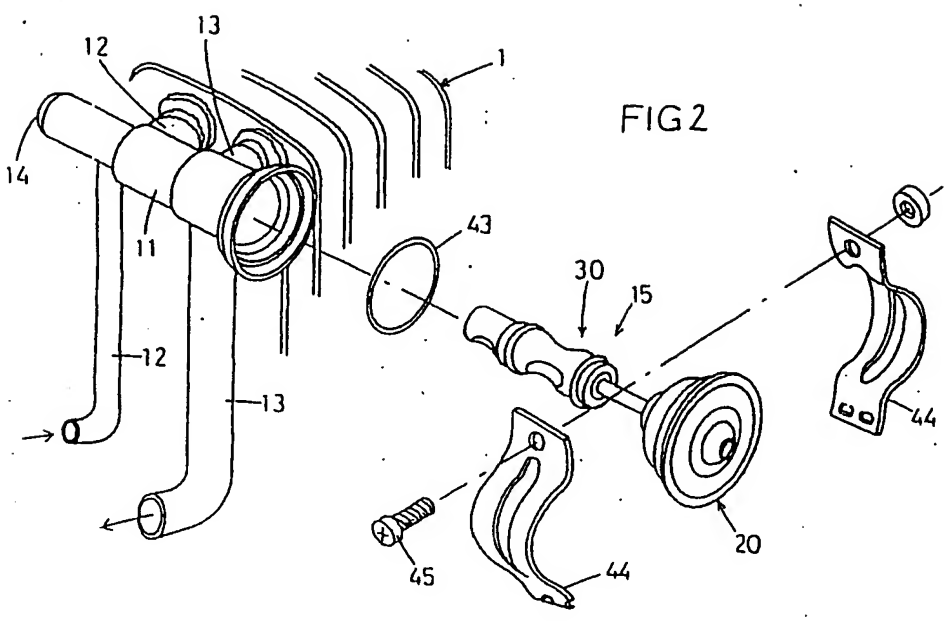

FIG 2

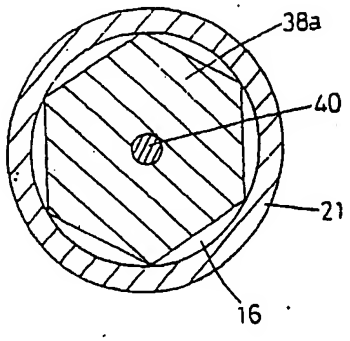

FIG 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number EP 95110177.3

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.6)
D,Y	EP - A - 0 513 568 (DEUTSCHE CONTROLS GMBH) * Fig. 1,4 *	1-4,7	F 25 B 41/06
A		5,6, 8-10, 12	
Y	EP - A - 0 486 224 (THERMO KING CORP.) * Fig. 2; abstract *	1-4,7	
A	US - A - 5 297 728 (YANO) * Totality *	1-8,12	
A	US - A - 4 149 390 (IIJIMA) * Totality *	1,4-8, 12-14	

TECHNICAL FIELDS SEARCHED (Int. Cl.6)

F 25 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	20-10-1995	WITTMANN

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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